

Los Alamos National Laboratory
Environmental Restoration Program
Standard Operating Procedure

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Geomorphic Characterization

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GEOMORPHIC CHARACTERIZATION

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GEOMORPHIC CHARACTERIZATION

1.0 PURPOSE

The purpose of this procedure is to standardize the geomorphic characterizations of sites investigated in the Environmental Restoration (ER) Program, including (1) preparation of maps of surficial deposits, landforms, and drainage channels, and (2) documentation of surficial processes that pertain to the potential erosion and deposition of contaminated soil and rock material.

2.0 SCOPE

2.1 Applicability

This procedure is applicable to all researchers working on the ER Program who are responsible for characterizing geomorphic features and geomorphic processes associated with site characterization activities.

2.2 Training

To implement this procedure, the user must be a professional geomorphologist, as designated by the ER Program Earth Sciences Team Leader or Geology Principal Investigator, or must be trained by a professional geomorphologist as designated by the Earth Sciences Team Leader or Geology Principal Investigator. Researchers conducting geomorphic characterization activities must also certify that they have read and understood this procedure, as well as the six procedures in Section 1.0, General Instructions.

3.0 DEFINITIONS

There are no unique definitions in this procedure.

4.0 BACKGROUND AND/OR CAUTIONS

The user will follow the general instructions for field personnel as specified in Standard Operating Procedure (SOP) Section 1.0, General Instructions.

5.0 EQUIPMENT

Topographic base map, at a scale appropriate to the task and specified beforehand in consultation with the Project Leader.

Aerial photographs of the site at a scale appropriate to the task. These photographs may include both overlapping vertical photographs that allow stereoscopic examination of the ground surface and oblique photographs that allow improved examination of certain features, such as canyon walls.

6.0 PROCEDURE

The geomorphic characterization activities associated with the ER Program are focused on the identification and description of surficial deposits and landforms that provide evidence for processes that can potentially result in the exposure and/or transport of contaminants. Processes of concern in this task are primarily surficial, specifically mass wasting on canyon walls and erosion associated with surface channels. Also of concern is evidence for lateral emergence of subsurface flow along canyon walls because of its importance in understanding groundwater flow paths and potential transport of contaminants.

Geomorphic characterization involves a thorough examination of the surficial features at sites of concern and in adjacent areas, with the areal extent of study dependent on site characteristics. The areal extent will be determined in consultation with the Project Leader. The size of the area appropriate for examination may vary with the processes under consideration. For example, a search for evidence of emergence of groundwater flow may be important at greater distances from waste sites than the search for evidence for sediment transport and storage on canyon walls. The focus of the geomorphic characterization may also vary dependent on the characteristics of the site. For example, whereas documentation of sites of erosion and deposition associated with drainage channels may be critical at sites where contaminants are or have been exposed at the surface, similar documentation may not be needed at sites where wastes have been deeply buried in rock. Similarly, examination of evidence for past and potential future landsliding on canyon walls may be critical for sites adjacent to the edges of mesas, but may be unnecessary where waste sites are set back a substantial distance from the canyon walls. Decisions concerning the size of the area appropriate for study and the critical processes at a site require professional judgment developed through experience with geomorphic characterization activities.

6.1 Mapping Surficial Deposits, Landforms, and Drainage Channels

Geomorphic features of significance to the investigation are to be located on topographic base maps. For many purposes, adequate location control can be provided by using topographic or man-made features shown on the base map, such as the course of drainage channels. If needed, more precise location control can be provided by using a tape and compass or surveying equipment such as a plane table and alidade, transit, theodolite, or total station.

Preliminary mapping of geomorphic features over a large area is most efficiently done using vertical aerial photographs that provide stereoscopic coverage. This allows rapid examination of the entire area of interest and an initial identification of areas of critical interest that require field checking. The examination of vertical aerial photographs can be supplemented by examination of oblique aerial photos, particularly of canyon walls, that allow improved resolution of detail.

Field checking of the preliminary map is required to confirm the accuracy of interpretations made on the aerial photographs, to locate features not visible on the photographs, and to conduct in depth examination of potentially critical features that provide evidence for processes that may influence the transport and deposition of contaminants. Often, the initial field checking is followed by re-examination of the entire area on the aerial photographs to adjust the preliminary mapping. The above process should be repeated, if necessary, until the geomorphic map adequately records the significant geomorphic features.

Features to be mapped may include:

- cliffs.
- bare bedrock slopes.
- slopes generally covered with a thin soil.
- slopes mantled with colluvial deposits (generally > 1.0 m thick).
- alluvial sediments along channels.
- soil-covered mesa tops.
- artificial fill and disturbed areas.
- drainage channels, distinguishing channels incised into erodible material by a separate symbol from channels not so incised.
- sites of possible or confirmed emergence of lateral groundwater flow, evidenced by observed springs; vegetation indicative of relatively moist conditions; distinct concavities on canyon walls or enlarged amphitheater-shaped drainage heads.
- features indicative of landsliding including: partially-detached blocks on or adjacent to canyon walls; partially-opened fractures near the edges of mesas; pronounced concavities or embayments along the canyon walls that are suggestive of locations of more rapid cliff retreat in the past than adjacent portions of cliffs; deposits of bouldery colluvial debris on canyon slopes or in canyon bottoms that may record large-scale slope failure in the past.

The geomorphic map shall include a legend in which all mapped features are included and described. Mapping units may include small areas with different characteristics, to be mentioned in the legend (for example, "Bare bedrock slopes: includes small, discontinuous areas of thin colluvial deposits").

6.2 Documentation of Surficial Processes

Evidence of the relevant surficial processes active at the sites of investigation is identified during the mapping of surficial deposits, landforms, and drainage channels. Observation sites may be recorded on aerial photographs, the topographic base map, and/or in field notebooks.

Evidence of surficial processes to be recorded may include:

- General variations in soil thickness on mesa tops, if possible, that may reflect long-term variations in the location and intensity of erosion. Relatively thick soils on gentle slopes or towards the center of mesas may reflect low erosion rates or long-term deposition of sediments, and relatively thin soils on steeper slopes and towards the edges of mesas reflect more intense surficial erosion.
- Drainages incised into alluvium or colluvium, specifying width, depth, and length of incision and nature of sediments that the channel is incised into.
- Exposure of roots of trees or shrubs, specifying depth of exposure and age of plant, if possible, as determined from tree rings; surface characteristics should also be recorded, as appropriate, including texture of surficial materials and the gradient of the ground surface.
- Differential erosion of canyon walls that may be related to variations in induration.
- Partially-detached landslide blocks, specifying position in relation to lithologic variations, and the length, width, estimated vertical extent, and apparent amount of previous movement.
- Partially-opened fractures near the edges of mesas, specifying apparent length, depth, orientation, distance from mesa edge, and relation to drainages on mesa.
- Pronounced concavities or embayments along the canyon walls that are suggestive of more rapid cliff retreat in the past than adjacent portions of cliffs or of sapping and erosion at sites of emergence of groundwater flow.
- Distinct deposits of bouldery colluvial debris that may record large-scale slope failure in the past, specifying size and apparent source.

- Springs, both perennial and intermittent, specifying geologic setting of spring, associated landforms such as concavities on canyon walls, and associated vegetation.
- Sites of sediment deposition and storage along streams and on slopes that pertain to transport of contaminants, specifying topographic position, estimated size of storage site, and associated erosional features such as rills or incised channels. Where appropriate, supporting information on the estimated age and history of the deposit should be included, using chronological techniques appropriate to the age range of concern and available datable materials or surfaces.

7.0 REFERENCES

LANL-ER-SOPs in Section 1.0, General Instructions

LANL-ER-AP-02.1, Procedure for Los Alamos National Laboratory ER Records Management

8.0 RECORDS

Documentation that person(s) implementing procedure are trained in geomorphic characterization. This documentation may include summary of education and experience in a curriculum vitae.

Observations and interpretations of geomorphic features and processes made in the field and during examination of aerial photographs will be recorded on maps, in field notebooks, and possibly on photographs. These observations and interpretations will be integrated into a report presenting the results of the geomorphic characterization activities, and this report will serve as the record of these activities. The report may include the following:

- a map or maps showing significant geomorphic features.
- figures illustrating important geomorphic features or relationships, such as: sketches of natural or artificial exposures; geologic cross sections made from field measurements or from topographic maps; cartoons schematically showing important features or interpretations.
- photographs of selected sites.
- tables presenting data from analyzed samples, field measurements, or other pertinent information.

These records shall be transferred to the ER Records Processing Facility in accordance with the Procedure for Los Alamos National Laboratory ER Records Management (LANL-ER-AP-02.1).

9.0 ATTACHMENTS

N/A